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Spacecraft Give 'Deeper' Picture of the Origin of Galaxies

By DENNIS OVERBYE

Astronomers unveiled the first results yesterday from what they said was the most searching look yet into the origin of galaxies and how they grew.

Staring at two patches of sky, one in the north and one in the south, NASA's Hubble Space Telescope and Chandra X-ray Observatory assembled a snapshot of cosmic history, the astronomers said, that reaches back to less than a billion years after the Big Bang in which the universe was born.

A billion years corresponds to about 8 percent of the age of the universe, said Dr. Mauro Giavalisco, an astronomer at the space telescope who was a leader of the survey known as the Great Observatories Origins Deep Survey, or Goods. That, Dr. Giavalisco said, is "the period when galaxies and humans evolved the quickest."

Dr. Niel Brandt, an X-ray astronomer at Pennsylvania State University, said, "We are seeing galaxy children."

Augmented by ground-based observatories and the soon-to-be launched Space Infrared Telescope Facility, which will perform its own sweep of the same patches of sky, Goods is a successor to earlier surveys in which the Hubble stared at a pair of tiny patches of sky, recording galaxies far back in time. The new survey is wider, encompassing an area of sky equal to about half of a full moon — an area 33 times as large as that covered by the earlier "deep field" effort — and containing some 50,000 galaxies. Moreover, because the Hubble's new Advanced Camera for Surveys has a greater sensitivity in the infrared part of the electromagnetic spectrum, it can see deeper into time. (Galaxies far, far away and thus back in time have their light shifted to longer infrared wavelengths.)

Among the surprises, Dr. Giavalisco said, is that the universe was copiously producing stars as early as a billion years of age. Some earlier surveys had suggested that star formation had started out slowly and then peaked until the universe was three billion to six billion years old.

According to the Goods results, however, star formation started out at a high rate and stayed that way until about seven billion years ago. Then the rate fell precipitously, perhaps because all the primordial hydrogen, the gas of which stars are made, had been used up or heated up too far to condense.

In the dark realm of black holes, meanwhile, evolution was following a different course.

Dr. Brandt described the X-ray half of the survey as "a black hole core sample" of the universe. The goal, he said, was to study the evolution of black holes — millions or billions times the mass of the Sun — thought to lurk in the centers of most galaxies belching X-rays as they swallow stray gas and stars.

"The Chandra data are very cool," said Dr. Michael Turner, a cosmologist at the University of Chicago, "because essentially every image you see is a supermassive black hole. Where else are black holes so easy to see?"

Out of the 540 black hole candidates that Chandra counted, however, only a handful seem to date from the first billion years, even though galaxies were already numerous then, Dr. Brandt said. Black holes do not seem to "turn on" until a billion years later.

The data could resolve a chicken-and-egg question about which come first, galaxies or the black holes inside them. "Our data suggest that the galaxies come first and then supermassive black holes grow inside them," Dr. Brandt said.

What happens next, he said, depends on the mass of the black hole, with more massive ones growing and becoming active more quickly and generally lodging in more luminous galaxies or quasars. The "heyday" of the quasars, home of super-mighty black holes, happened when the universe was two billion to four billion years old, Dr. Brandt said, but the numbers of more moderate mass black holes, as registered by their X-ray activity, peaked when the universe was about 10 billion years old.

About seven of the black holes in the new survey have no optical counterparts, Dr. Brandt said. They could be in galaxies even more distant in time, in the so-called ages when the universe was only half a billion years old and still swaddled in gas that blocked all light, or they could be closer but swaddled in thick dust.

"They are very exciting, no matter what they are," Dr. Brandt said.

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